Advanced Deterministic Transport Methods

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Overview

Solution Techniques
Discretization Techniques
A Next-Generation Deterministic Transport Code
Traditional Deterministic Code Development

Solution Techniques

- Significant advances have been made for both inner and outer iteration convergence acceleration, but DSA and DSA-like methods have been found to fail in certain circumstances even with fully consistent diffusion discretizations.
- Recasting accelerated iteration schemes as preconditioned Krylov methods is revolutionizing the way we solve the transport equation.
- This approach yields great flexibility and unconditional stability.
- Krylov methods can be used for eigenvalue calculations as well as source calculations.

Discretization Techniques

- Significant advances have been made in nonorthogonal-mesh S_n spatial discretization schemes.
- Angular S_n discretization techniques for the angular derivative term in curvilinear coordinates have received little attention, but limit the S_n method to first-order accuracy in such geometries.
- The energy discretization can easily be the largest source of error, but little has been done to move beyond the multigroup method.
- Time discretization treatments can easily be improved via discontinous finite-element and multistep-implicit methods.
- Significant advances have been made for charged-particle transport, but we lack multigroup cross section data for many types of charged-particles.

A Next Generation Code

- Preconditioned Krylov solution techniques.
- S_n Discretization.
- Non-orthogonal meshes: unstructured or structured.
- Massively Parallel.
- Time-dependent, steady-state, or eigenvalue capability.
- Neutral, charged-particle, or coupled multi-particle capability (requires data).
- Modular structure for facilitating multi-physics implementations.
- High potential impact in reactor physics, health physics, shielding, etc.

Traditional Deterministic Code Development

- Until the late 80's, large Sn code-development groups were supported at Los Alamos and Oak Ridge to build general-purpose neutral-particle codes for the nuclear community.
- These codes played a community-wide role as both research platforms and production codes.
- University researchers need such computational research platforms more than ever before.
- A single student cannot build a parallel 3-D unstructured-mesh Sn code as part of a dissertation project.
- In general, building the software infrastructure required for modern computational transport research via a succession of students is extremely difficult.
- Open source development techniqes might provide a paradigm for the development of a new generation of general-purpose transport codes.